PORTABLE TELEPHONE SYSTEM CAPABLE OF
SIMULTANEOUSLY CARRYING OUT
HIGH SPEED COMMUNICATION AND LOW SPEED COMMUNICATION
BY ONE TIME SLOT AND COMMUNICATION METHOD THEREFOR

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a portable telephone system such as a personal handyphone system (PHS),
10   and more particularly, to the improvement of a speech communication and a data communication in a time division multiple access (TDMA) portable telephone system.

Description of the Related Art

A typical TDMA portable telephone system is a PHS.

15   A first prior art PHS including a base station and a mobile station (PHS terminal) carries out a communication by one time slot assigned thereto. That is, when a service is requested from the PHS terminal through a control channel to the base station, the base station determines a protocol for
20   the service, so that either a speech communication or a conventional data communication is carried out by using an assigned time slot.

In the above-described first prior art PHS, however, since only one time slot is assigned to a speech communication
25   or a conventional data communication, it is impossible for the PHS terminal to simultaneously carry out a speech communication and a conventional data communication. As a result, when a speech communication is requested while a conventional data communication is being carried out, this
30   speech communication is rejected. On the other hand, when a conventional data communication is requested while a speech communication is being carried out, this conventional data communication is rejected.

A second prior art PHS carries out a speech
35   communication and a conventional data communication by two

time slots simultaneously (see: JP-A-2000-13858). That is, when a first service is requested from the PHS terminal through the control channel to the base station, the base station determines a protocol for the first service, so that the first service is carried out by using one assigned time slot. Next, while the first service is being carried out, when a second service is requested from the PHS terminal through the control channel to the base station, the base station determines a protocol for the second service, so that the second service is carried out by another assigned time slot.

 In the above-described second prior art PHS, however, since a plurality of time slots are assigned to one PHS terminal, effective use is not made of time slots, i.e., channels. In other words, a large number of channels are consumed, so that other communication for the base station would be interrupted.

SUMMARY OF THE INVENTION
 It is an object of the present invention to provide a portable telephone system simultaneously capable of a high speed communication such as a speech communication or a PHS Internet Access Forum Standard (PIAFS) data communication and a conventional data communication such as an i-mode data communication by using one time slot.
 Another object is to provide a communication method for the above-mentioned portable telephone system.
 Note that the PIAFS data communication as well as the speech communication requires a high speed communication. Also, a facsimile data communication may require a high speed communication. On the other hand, an "i-mode" data communication provided by NTT DoCoMo, Japan, which is a kind of Internet Browser service (Internet connection PHS service), does not require a high speed communication. Therefore, the conventional data communication includes such an i-mode data communication.

According to the present invention, in a portable telephone system including a base station and a mobile station which communicate with each other by using one time divisional time slot including a high speed channel and a low speed channel, a first communication requiring the high speed channel by a first calling party from the base station to the mobile station and a second communication not requiring the high speed channel by a second party from the base station to the mobile station are carried out simultaneously by using the high speed channel and the low speed channel, respectively.

Note that the low speed channel corresponds to the control channel of the prior art.

Also, in a communication method for a portable telephone system including a base station and a mobile station which communicate with each other by using one time divisional time slot including a high speed channel and a low speed channel, it is determined whether or not the high speed channel is empty, when a new service is requested from the base station to the mobile station using the low speed channel. Then, the new service is assigned to the high speed channel, when the high speed channel is empty.

Also, it is determined whether or not the low speed channel is empty, when the high speed channel is not empty. Then, it is determined whether the new service is related to a first communication which requires the high speed channel or a second communication not requiring the high speed channel, when the low speed channel is empty. Then, the new service is assigned to the low speed channel, when the new service is related to the second communication.

Further, the new service is assigned to no channel, when the low speed channel is not empty.

Additionally, it is determined whether a service occupying the high speed channel is a service relating to the first communication or a service relating to the second communication, when the new service is related to the first

communication. Then, the service occupying the high speed
channel is moved to the low speed channel, and the new service
is assigned to the high speed channel, when the service
occupying the high speed channel is a service relating to the
5   second communication.

Further, the new service is assigned to no channel,
when the service occupying the high speed channel is a service
relating to the first communication.

10   BRIEF DESCRIPTION OF THE DRAWINGS
The present invention will be more clearly
understood from the description set forth below, with
reference to the accompanying drawings, wherein:
Fig. 1 is a block circuit diagram illustrating an
15   embodiment of the portable telephone system according to the
present invention;
Fig. 2 is a diagram showing a time divisional time slot
of a radio interface between the base station and the mobile
station of Fig. 1;
20   Fig. 3 is a flowchart for explaining the operation of the
portable telephone system of Fig. 1;
Figs. 4A and 4B are sequence diagrams for explaing the
operation of steps 301 and 302 of Fig. 3;
Fig. 5 is a sequence diagram for explaining the operation
25   of steps 301, 303, 304 and 305 of Fig. 3;
Fig. 6 is a sequence diagram for explaining the operation
of steps 301, 303, 304, 306 and 307 of Fig. 3;
Fig. 7A is a sequence diagram for explaining the
operation of steps 301, 303 and 308 of Fig. 3;
30   Fig. 7B is a sequence diagram for explaining the
operation of steps 301, 303, 304, 306 and 308 of Fig. 3;
Fig. 8 is a block circuit diagram illustrating a
modification of the portable telephone system of Fig. 1;
Fig. 9 is a block circuit diagram illustrating a
35   modification of the portable telephone system of Fig. 8; and

Fig. 10 is a block circuit diagram illustrating a modification of the portable telephone system of Fig. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT

5   In Fig. 1, which illustrates an embodiment of the portable telephone system according to the present invention, reference numeral 1 designates a private branch exchange connected to a server 2 for a conventional data communication such as an i-mode communication, a PIAFS data communication

10   and a facsimile data communication, and an extension unit 3 and a trunk 4 for a speech communication. Also, a base station 5 is connected to the private branch exchange 1 to communicate with a mobile station 6.

As shown in Fig. 2, a radio interface between the

15   base station 5 and the mobile station 6 is a time divisional time slot which includes a low speed channel LCH whose speed is 3.2 kbps, for example, and a high speed channel HCH whose speed is 32 kbps, for example.

The portable telephone system of Fig. 1 using the

20   radio interface as shown in Fig. 2 can be applied to a conventional PHS system so that effective use is made of the limited communication channel resource.

When a speech communication, a PIAFS data communication or a facsimile data communication is realized

25   between the base station 5 and the mobile station 6, speech information, PIAFS data or facsimile data occupies the high speech channel HCH while control information is transmitted through the low speech channel LCH. In this case, since the control information transmitted through the low speech

30   channel LCH is small, an empty channel would be generated in the band of the low speech channel LCH. In the present invention, effective use is made of such an empty channel in the band of the low speech channel LCH. That is, when a conventional data communication request such as an i-mode data

35   communication request occurs while a speech communication, a

PIAFS data communication or a facsimile data communication is being carried out, the conventional data communication is carried out through the empty band of the low speech channel LCH.

5   The operation of the portable telephone system of Fig. 1 will be explained next with reference to Fig. 3, which is a flowchart for assigning a new service to a channel. The operation of Fig. 3 starts every time such a new service is requested for the mobile station 6.

10   First, at step 301, it is determined whether or not the high speed channel HCH is empty. Only when the high speed channel HCH is empty, does the control proceed to step 302 which assigns the new service to the high speed channel HCH. This will be explained later in detail with reference to Figs. 4A and 4B. Otherwise, the control proceeds to step 303.

     At step 303, it is determined whether or not the low speed channel LCH is empty. Only when the low speed channel LCH is empty, does the control proceed to step 304. Otherwise, the control proceeds to step 308 which assigns the new service to no channel. This will be explained later in detail with reference to Fig. 7A.

     At step 304, it is determined whether or not the new service is a service relating to a speech communication (or a PIAFS data communication, a facsimile data communication) or a service relating to a conventional data communication such as an i-mode data communication. Only when the new service is a service relating to the conventional data communication, does the control proceed to step 305 which assigns the new service to the low speech channel LCH. This will be explained later in detail with reference to Fig. 5. Otherwise, i.e., when the new service is a service relating to a speech communication (or a PIAFS data communication, a facsimile data communication), the control proceeds to step 306.

     At step 306, it is determined whether or not a speech communication (or a PIAFS data communication, a facsimile data

communication) or a conventional data communication is already occupying the high speed channel HCH. Only when a conventional data communication is occupying the high speed channel HCH, does the control proceed to step 307 which moves the conventional data communication to the low speed channel LCH and assigns the new service to the high speed channel HCH. This will be explained later in detail with reference to Fig. 6. Otherwise, i.e., when a speech communication (or a PIAFS data communication, a facsimile data communication) is occupying the high speed channel HCH, the control proceeds to step 308 which assigns the new service to no channel. This will be explained later in detail with reference to Fig. 7B.

Fig. 4A is a sequence diagram for explaining the operation of steps 301 and 302 of Fig. 3. That is, when the high speed channel HCH is empty, it is assumed that a new service of a speech communication, a PIAFS data communication or a facsimile data communication is requested from the private branch exchange 1 to the mobile station 6.

First, a call set-up message ST having a call reference CR1 for a speech communication, a PIAFS data communication or a facsimile data communication is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the high speed channel HCH is empty, the mobile station 6 transmits an acceptance message ACC via the base station 5 to the private branch exchange 1 using the low speed channel LCH. In this case, the mobile station 6 assigns the speech communication, the PIAFS data communication or the facsimile data communication having the call reference CR1 to the high speed channel HCH.

Next, the mobile station 6 transmits a call set-up message ST for the call reference CR1 via the base station 5 to the private branch exchange 1 using the low speed channel LCH. Then, the private branch exchange 1 generates an acknowledgement message ACK in response to the call set-up

message ST for the call reference CR1.

Thus, a speech path, a PIAFS data path or a facsimile data path is established in the high speech channel HCH between the private branch exchange 1 and the mobile station 6.

Fig. 4B is a sequence diagram for explaining the operation of steps 301 and 302 of Fig. 3. That is, when the high speed channel HCH is empty, it is assumed that a new service of a conventional data communication such as an i-mode data communication is requested from the private branch exchange 1 to the mobile station 6.

First, a call set-up message ST having a call reference CR1 for a conventional data communication is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the high speed channel HCH is empty, the mobile station 6 transmits an acceptance message ACC via the base station 5 to the private branch exchange 1 using the low speed channel LCH. In this case, the mobile station 6 assigns the conventional data communication having the call reference CR1 to the high speed channel HCH.

Next, the mobile station 6 transmits a call set-up message ST for the call reference CR1 via the base station 5 to the private branch exchange 1 using the low speed channel LCH. Then, the private branch exchange 1 generates an acknowledgement message ACK in response to the call set-up message ST for the call reference CR1.

Thus, a conventional data path, i,e., an i-mode data path is established in the high speech channel HCH between the private branch exchange 1 and the mobile station 6.

Fig. 5 is a sequence diagram for explaining the operation of steps 301, 303, 304 and 305 of Fig. 3. That is, when the high speed channel HCH is occupied by a speech communication, a PIAFS data communication or a facsimile data communication having a call reference CR1 but the low speed channel LCH is empty, it is assumed that a new service of a

conventional data communication such as an i-mode data communication is requested from the private branch exchange 1 to the mobile station 6.

First, a call set-up message ST having a call reference CR2 for a conventional data communication is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the low speed channel LCH is empty, the mobile station 6 transmits an acceptance message ACC via the base station 5 to the private branch exchange 1 using the low speed channel LCH. In this case, the mobile station 6 assigns the conventional data communication having the call reference CR2 to the high speed channel HCH.

Next, the mobile station 6 transmits a call set-up message ST for the call reference CR2 via the base station 5 to the private branch exchange 1 using the low speed channel LCH. Then, the private branch exchange 1 generates an acknowledgement message ACK in response to the call set-up message ST for the call reference CR2.

Thus, a conventional data path, i.e., an i-mode data path is established in the low speech channel LCH between the private branch exchange 1 and the mobile station 6.

Next, after the conventional data communication is completed, the private branch exchange 1 generates an end of procedure (EOP) message for the call reference CR2 and transmits it via the base station 5 to the mobile station 6 using the low speed channel LCH. As a result, the conventional data path is dissolved, thus releasing the low speed channel LCH. Thus, only the speech path, the PIAFS data path or the facsimile data path remains in the high speed channel HCH between the private branch exchange 1 and the mobile station 6.

In Fig. 5, although the conventional data communication is completed while the speech communication, the PIAFS data communication or the facsimile data

communication is being carried out, it is possible that the speech communication, the PIAFS data communication or the facsimile data communication is completed while the conventional data communication is being carried out.

5   Fig. 6 is a sequence diagram for explaining the operation of steps 301, 303, 304, 306 and 307 of Fig. 3. That is, when the high speed channel HCH is occupied by a conventional data communication having a call reference CR1 but the low speed channel LCH is empty, it is assumed that a

10   new service of a speech communication, a PIAFS data communication or a facsimile data communication is requested from the private branch exchange 1 to the mobile station 6.

      First, a call set-up message ST having a call reference CR2 for a speech communication, a PIAFS data

15   communication or a facsimile data communication is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the low speed channel LCH is empty, the mobile station 6 moves the conventional data communication having the

20   call reference CR1 to the low speed channel LCH. Then, the mobile station 6 transmits an acceptance message ACC via the base station 5 to the private branch exchange 1 using the low speed channel LCH. In this case, the mobile station 6 assigns the speech communication, the PIAFS data communication or the

25   facsimile data communication having the call reference CR2 to the high speed channel HCH.

      Next, the mobile station 6 transmits a call set-up message ST for the call reference CR2 via the base station 5 to the private branch exchange 1 using the low speed channel

30   LCH. Then, the private branch exchange 1 generates an acknowledgement message ACK in response to the call set-up message ST for the call reference CR2.

      Thus, a speech path, a PIAFS data path or a facsimile data path is established in the high speed channel HCH between

35   the private branch exchange 1 and the mobile station 6, and

a conventional data path, i.e., i-mode data path is established in the low speech channel LCH between the private branch exchange 1 and the mobile station 6.

Next, after the speech communication, the PIAFS data communication or the facsimile data communication is completed, the private branch exchange 1 generates an EOP message for the call reference CR2 and transmits it via the base station 5 to the mobile station 6 using the low speed channel LCH. As a result, the speech, PIAFS or facsimile data path is dissolved, thus releasing the high speed channel HCH. Thus, only the i-mode data path remains in the low speed channel LCH between the private branch exchange 1 and the mobile station 6.

In Fig. 6, although the conventional data communication is completed while the speech communication, the PIAFS data communication or the facsimile data communication is being carried out, it is possible that the speech communication, the PIAFS data communication or the facsimile data communication is completed while the conventional data communication is being carried out.

Fig. 7A is a sequence diagram for explaining the operation of steps 301, 303 and 308 of Fig. 3. That is, when the high speed channel HCH is occupied by a speech communication, a PIAFS data communication, a facsimile data communication or a conventional data communication having a call reference CR1, and the low speed channel LCH is occupied by a conventional data communication having a call reference CR2, it is assumed that a new service of one communication type is requested from the private branch exchange 1 to the mobile station 6.

First, a call set-up message ST having a call reference CR3 for the new service is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the low speed channel LCH and the high speed channel HCH are both occupied,

so that there is no available channel. Therefore, the mobile station 6 transmits an EOP message via the base station 5 to the private branch exchange 1 using the low speed channel LCH.

Thus, no new path is established between the private branch exchange 1 and the mobile station 6.

Fig. 7B is a sequence diagram for explaining the operation of steps 301, 303, 304, 306 and 308 of Fig. 3. That is, when the high speed channel HCH is occupied by a speech communication, a PIAFS data communication or a facsimile data communication having a call reference CR1 but the low speed channel LCH is empty, it is assumed that a new service of a speech communication, a PIAFS data communication or a facsimile data communication is requested from the private branch exchange 1 to the mobile station 6.

First, a call set-up message ST having a call reference CR2 for a speech communication, a PIAFS data communication or a facsimile data communication is transmitted from the private branch exchange 1 via the base station 5 to the mobile station 6 using the low speed channel LCH. Since the high speed channel HCH is already occupied by a speech communication, a PIAFS data communication a facsimile data communication, it is impossible for another speech communication, another PIAFS data communication or another facsimile data communication to occupy the high speed channel HCH. Therefore, the mobile station 6 transmits an EOP message via the base station 5 to the private branch exchange 1 using the low speed channel LCH.

Thus, no new path is established between the private branch exchange 1 and the mobile station 6.

According to the above-described embodiment, the mobile station 6 can carry out a speech communication (or a PIAFS data communication, a facsimile data communication) with a party and a conventional data communication such as an i-mode data communication with another party simultaneously. Therefore, when a conventional data communication is

requested while a speech communication (or a PIAFS data
communication, a facsimile data communication) is being
carried out, the conventional data communication can be
carried out without interrupting the speech communication (or

5 the PIAFS data communication, the facsimile data
communication), thus improving the operativity and reducing
the time consumption. Similarly, when a speech communication
(or a PIAFS data communication, a facsimile data
communication) is requested while a conventional data

10 communication is being carried out, the speech communication
(or the PIAFS data communication, the facsimile data
communication) can be carried out without interrupting the
conventional data communication, thus improving the
operativity and reducing the time consumption.

15   Also, since a conventional data communication is
carried out through the empty band of the low speed channel
LCH, effective use is made of the channel resource. For example,
when a conventional data communication is requested while a
speech communication, a PIAFS communication or a facsimile

20 data communication is being carried out, the communication
being blocked by the channel resource never occurs.

        In Fig. 8, which illustrates a modification of the
portable telephone system of Fig. 1, a display unit 61 is
provided in the mobile station 6, thus accessing short

25 messages and E-mails stored in the server 2 and the Internet
via the server 2. In this case, the conventional data
communication includes the access of such short messages
E-mails and the Internet.

        In Fig. 9, which illustrates a modification of the

30 portable telephone system of Fig. 8, the movible station 6 is
connected by a PIAFS cable to a personal computer 7, thus
carrying out a PIAFS data communication by the personal
computer 7 in addition to the mobile station 6 per se.

        In Fi. 10, which illustrates a modification of the

35 portable telephone system of Fig. 9, the connection between

the mobile station 6 and the personal computer 7 is carried out by a radio interface 9 such as an Infrared Data Association (IrDA) interface or a Bluetooth interface.

5   The present invention can be applied to portable telephone systems other than the PHS.

As explained hereinabove, according to the present invention, the mobile station can carry out a speech communication (or a PIAFS data communication, a facsimile data communication) and a conventional data communication such as 10   an Internet connection PHS data communication simultaneously.